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SOIL and WATER MANAGEMENT in Irrigated Sugar Beet Fields

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SOIL and WATER MANAGEMENT in Irrigated Sugar Beet Fields

By Jay L. Haddock, *soil scientist, Soil and Water Conservation Research Division, Agricultural Research Service*

Growing sugar beets on irrigated land is profitable only if yields are high—and high yields are impossible without good soil- and water-management practices. Do these things:

- Adopt a crop rotation that enables you to get full value from the resources of your soil.
- Improve the structure of your soil.
- Make sure that soil is properly prepared for planting.
- Plant as early in the spring as possible.
- By proper cultivating and thinning, give your sugar beets a chance to grow.
- Prepare for early irrigation. Irrigate generously but judiciously.
- Don't overlook the possibility that your fields may become saline.
- Supply adequate commercial nitrogen. Supply commercial phosphorus when soil analysis indicates that it is needed.

CROP ROTATION

The main reasons for crop rotation in sugar beet production are (1) to increase active organic matter in the soil, (2) to make more efficient use of available plant nutrients in the soil, and (3) to aid in control of harmful weeds, insects, and nematodes.

Farmers in the irrigated sugar beet areas select their rotations from a variety of crops. Alfalfa for hay is usually grown for 3 or 4 years. Sweet corn or potatoes, sugar beets, and small grain or canning peas follow the alfalfa in the order given. Tomatoes, cotton, or melons are worked into the rotation in some parts of California.

Sweet corn or potatoes do well following alfalfa. Cultivation of either of these crops helps prepare the soil for the seeding of sugar beets. Alfalfa for the next cycle in the rotation can be seeded when the small grain or canning peas are seeded.

Examples of rotations used by successful sugar beet growers follow:

1. Snake-Columbia River drainage basins
   - *a.* Northern Utah-Southern Idaho area: Alfalfa for hay (3 years), sweet corn or potatoes, sugar beets, small grain or canning peas (seeded to alfalfa).
   - *b.* Boise Valley: Corn (3 years), corn or potatoes, sugar beets, onions or beans.
   - *c.* Yakima Valley: Corn (for grain, stubble plowed under), sweet corn (for canning, stalks plowed under), sugar beets.
2. California
   - *a.* Coastal area: Alfalfa (4 years), potatoes, sugar beets, small grain.
   - *b.* Sacramento Valley and northern San Joaquin Valley: Alfalfa (4 years), tomatoes, sugar beets, barley, sugar beets.
   - *c.* Southern San Joaquin Valley and Imperial Valley: Small grain, sugar beets, cotton, melons, sugar beets.
3. Eastern slope of the Rocky Mountains: Alfalfa (2 years), corn for silage, sugar beets, beans, sugar beets, small grains (seeded to alfalfa).

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IMPROVING SOIL STRUCTURE

Adding barnyard manure to the soil before planting sugar beets supplies the organic matter that is usually needed to improve soil structure. It also supplies nutrients. When enough barnyard manure is available, less attention needs to be given to crop rotation and commercial fertilizers.

In the fall, before each sugar beet year, add 8 to 12 tons of barnyard manure per acre to your sugar beet fields. Each ton applied may be worth $2 to $3 in increased yields.

If barnyard manure is not available, use crop residues (fig. 1) and green manure as sources of organic matter. If alfalfa is used, crown the crop (or kill it with 2,4-D spray) in September and plow it under 1 or 2 weeks later.

SOIL PREPARATION

High yields of sugar beets depend on good, evenly spaced stands—and good stands depend on adequate soil preparation.

Except in areas where the soil is subject to fall, winter, and early spring blowing, soil intended for growing sugar beets should be plowed in the fall (fig. 2). Fall plowing helps conserve moisture and therefore gives the grower the important advantage of being able to prepare the seedbed, and to plant early in the spring.

In the spring, as soon as the soil is dry enough, harrow and level the field in a direction diagonal to that in which it was plowed. Harrow again at right angles to the direction in which the field will be seeded. Perform these operations in rapid succession, to prevent loss of moisture.

***Figure 1.*—Chopping crop residue preparatory to plowing—an important step in soil management for sugar beets.**

When sugar beets are planted in beds, prepare the beds roughly in the fall. Firm and finish them for seeding in the spring.

PLANTING

The sugar beet plant uses any length season from 4 to 12 months. The longer the season, other things being equal, the higher the yield. It is, therefore, advantageous to plant sugar beets as early in the season as possible after the last killing spring frost.

Early planting dates differ in different parts of the same area. In central Washington, for example, plantings made between February 25 and March 1 are considered early; for such areas as Nyssa, Oreg., the Boise Valley, and early areas in Colorado, an early date would be between March 10 and March 20; for other irrigated areas, excluding California, early planting dates are between March 15 and April 15. In Cali-

fornia, planting dates are between October 15 and March 15.

Sugar beets should be planted about 1 inch apart and 1 inch below the surface in 22-inch rows. Many growers in California use 30-inch rows. Do not operate your planter at speeds greater than 3 miles per hour. Proper planting contributes to the establishment of uniform stands. Uniform stands make the work of cultivating and thinning easier—and yields higher.

CULTIVATION

Cultivating, thinning, and weeding are all parts of one operation. None of these can be satisfactory unless all previous operations have been done properly. A good crop rotation, timely soil preparation, and proper planting largely determine the success of all subsequent mechanical operations. The objective should be sufficient cultivation for complete weed control and adequate thinning of plant population with a minimum of field traffic.

No hard-and-fast rules for cultivation will apply to all sugar beet fields. Plant population, soil texture, and quantity and nature of weeds all help to determine when and how often to cultivate.

The first cultivation should include the use of a finger-weeder, a flex-tooth harrow (teeth vertical), or a spike-tooth harrow (teeth sloped at 45°). Cultivate straight across the rows 5 or 6 days after planting. The depth of teeth penetration should be three-fourths of an inch. By the time the beet plants are 1 inch tall and before they reach the four-leaf stage, this operation should be repeated in the direction

Figure 2.—**Plowing in the fall. A good job of fall plowing facilitates seedbed preparation in the spring.**

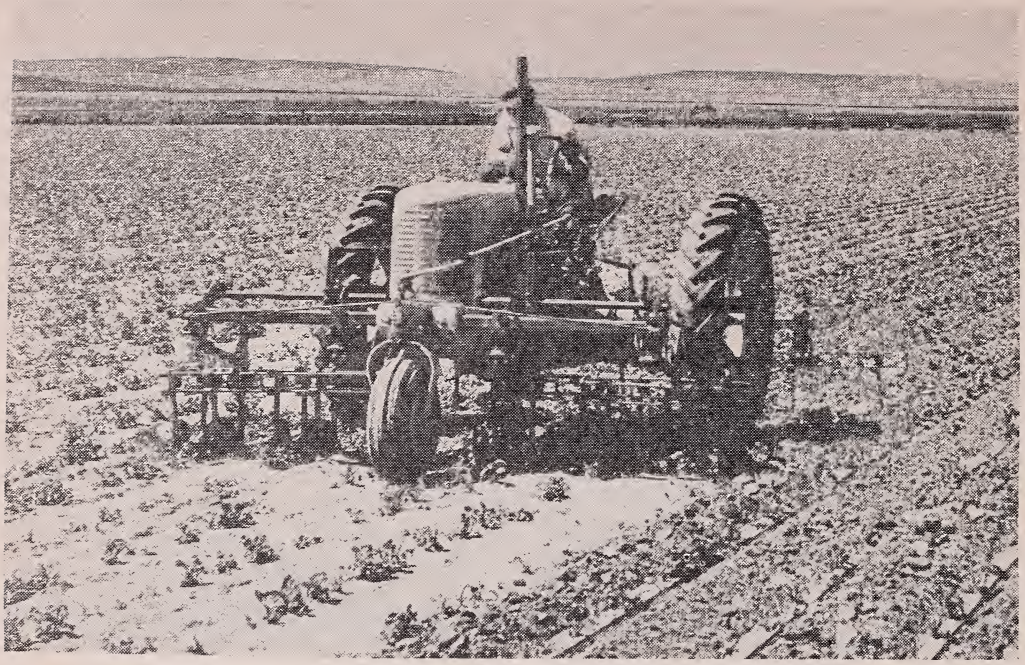

Figure 3.—**Down-the-row cultivation of sugar beets. Disk weeders and knife weeders are on front bar; duckfeet, on rear bar.**

opposite to the first weeding. Additional cultivation, thinning, and weeding may follow these two harrowings. The following three alternative procedures are of greatest promise: (1) Cross-harrowing with the flex-tooth (Melroe-type) harrow with gage wheels, (2) cross-blocking, or (3) down-the-row operation.

Cross-harrowing with the flex-tooth harrow two or three times (with the teeth in vertical position) when beet plants are between the four- and eight-leaf stage of growth, should accomplish adequate stand reduction. A minimum of thinning with the long-handled hoe to remove plant clusters and weeds is necessary and worthwhile under this system as it is with the other systems of spring mechanization. A final cross-harrowing with the flex-tooth harrow after the long-handled hoe has been found helpful by many growers.

Cross-blocking is frequently accomplished by using 2-inch knives, leaving 1-inch blocks. This operation should be done when the beets are small (four-leaf stage). A final thinning with the long-handled hoe is imperative with this method.

Down-the-row cultivation and thinning should be started when the beets are small (four-leaf stage). The following assembly (fig. 3) on your cultivator does a good job:

Set small disks 3 inches apart straddle each beet row.

Clamp cultivator knives immediately back of the disks.

Place duckfeet in center of the row evenly spaced between the cultivator knives.

The disks loosen the soil near the row. The cultivator knives kill the weeds near the beet row and push the loose soil back up to the uncultivated

land. The duckfeet loosen the soil after the tractor wheels and remove weeds from the center of the row. A second cultivation 2 to 3 weeks after thinning is necessary in most sugar beet fields. The following assembly (fig. 4) on your cultivator is good for this operation:

Weeder knives on first bar.

Sinner weeder blades or diamond points on second bar.

Ditching shovels on rear bar.

The best assembly to use for the first thinning is a down-the-row mechanical thinner (eight 1½-inch knives) on a single head. For the second thinning, use a tandem head of eight knives on each hub (½-inch cut). The amount of thinning needed should determine the size of knife selected. Thin the second time in a direction opposite to the direction of the first thinning (fig. 5).

Regardless of which of the three mechanical methods described above is used, the thinning operation is completed by removal of beet clumps at the first hand-hoeing operation. These operations may not leave single beets perfectly spaced to 12 inches, but if you have reduced the number of beet plants to 120 to 140 plants per 100 feet of row, you have done an excellent job.

IRRIGATION

Sprinkler irrigation is often better than furrow irrigation. It distributes the water more efficiently. It seems to be more effective for the preplanting, preemergence, and after-thinning irrigation of sugar beets. Furrow irrigation, however, has become established in the sugar beet growing areas of the West (fig. 6).

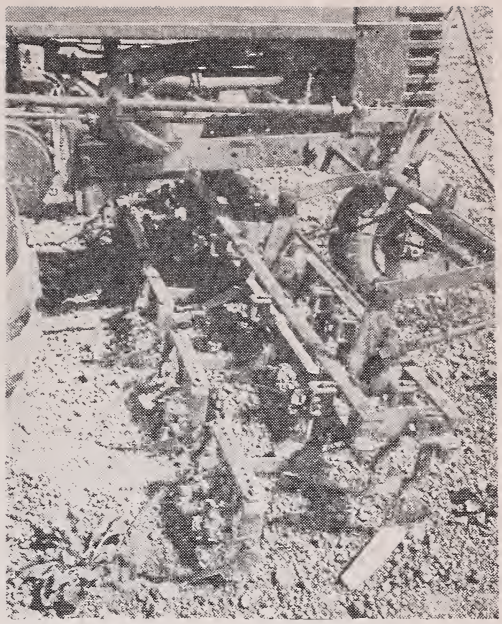

***Figure 4.*—Cultivator assembly for the second cultivation of sugar beets. Weeder knives are on the first bar; sinner weeder blades, on the second bar.**

Preparing for Irrigation

Prepare the land for irrigation at the time of seeding, even though you may not need to irrigate immediately following seeding. Install corrugators (marker shovels) on your planter in such a way that small, firm furrows are made in alternate rows. If these furrows are not needed for irrigation to insure germination, they serve as guides for early cultivation and final furrowing.

As soon as early thinning and weeding are completed, construct furrows between rows for irrigation. This is frequently done at the first cultivation (subsequent to thinning) with special shovels attached to the rear tool bar.

A desirable length of furrow between cross ditches is 500 to 600 feet. You may find that 300 feet is long enough. A few farmers use furrows 1,000 feet in length. The slope of your land and

Figure 5.—**Tandem heads that have eight knives on each hub, used for the second thinning of sugar beets.**

the water intake rate of your soil should determine the length of furrow. Consult your county agent or a representative of the Soil Conservation Service for recommendations.

When To Irrigate

In most parts of the sugar beet growing areas, sugar beets use about 1 inch of water every 10 days up to July; 2 inches of water every 10 days during July; 2.5 inches every 10 days during August; and 1.5 inches every 10 days during September.

Sugar beet plants depend on the available moisture in the first foot of soil for approximately 65 percent of their water. Consequently, the place to watch is the 1-foot depth. Check it frequently. Consider the consumptive use rates given. If a soil sample taken from 1 foot below the surface crumbles when squeezed in the fist, it is time to irrigate.

On the eastern slope of the Rocky Mountains, the interval between irrigations during most of the season is 10 to 14 days. In the States or parts of States between the Rockies and the Cascade and Sierra Nevada ranges, the interval is 7 to 10 days. The intervals shorten in this intermountain area because irrigation is the only important source of moisture.

How Much Water To Apply

Underirrigation slows sugar beet growth. Overirrigation may leach nutrients beyond the reach of sugar beet roots.

Irrigations before plants attain the four-leaf stage of growth should always be light. Root development at this time is scanty. Moistening more than the first 6 inches of soil is wasteful.

After sugar beet plants are thinned, irrigate as often as necessary to keep them growing rapidly. This usually

means the application of about 2 inches of irrigation water at each of two irrigations in June; 3 inches at each of four irrigations in July; 3 inches at each of four irrigations in August; and 2 inches at each of three irrigations in September. This is considerably more than is consumptively used during these periods. The excess is needed because not all of the water that is applied to a field sinks into the soil and remains there for plant use.

The time during which irrigation water must be in contact with a soil in order to supply 3 inches of irrigation water depends upon the water intake rate of the soil. A fine sandy loam that has a water-intake rate of 2 inches per hour may be adequately irrigated in 1½ hours. A clay loam that has an intake rate of one-fourth inch per hour may require a water-soil contact of 12 hours.

SALINITY

Sugar beet seeds may not germinate and grow in saline soils. Once established, however, sugar beets tolerate moderate salinity. The salinity status of a soil can be determined by tests. For testing information, contact your county agent, sugar beet company fieldman, or a soil-testing laboratory.

If you find that salinity interferes with the germination or early growth of your sugar beets, plant above the irrigation waterline and 3 or 4 inches to the side of a furrow on a slope. This will move the salt up beyond the seed and allow the seed to germinate and the young plants to become established. After the plants are established, relocate permanent furrows in the middle of each row.

Salinity will not be a problem if your fields are adequately drained. Winter flooding and preemergence irrigation help leach harmful salts out of the soil.

FERTILIZER

Fertilization must never be thought of as a means of overcoming poor husbandry elsewhere in the farming operation.

Well-managed soils provide a large part of the plant nutrients needed for a sugar beet crop. In most sugar beet growing areas, unfertilized soils supply sufficient essential plant nutrients to produce 15 to 16 tons of beets per acre without commercial fertilizer. However, in order to produce the bumper 20- to 30-ton crops possible in most areas, you must add commercial fertilizer supplements.

The important questions are: (1) How much of these nutrients should the farmer use under his particular conditions? and (2) How frequently and to which crops in the rotation should fertilizers be supplied?

Nitrogen

A deficiency of available soil nitrogen even at midseason markedly limits yields of roots. An excess of available soil nitrogen exerts a depressing influence on the sugar percentage of beet roots. This peculiarity of nitrogen makes it imperative that the nitrogen requirement of the sugar beet crop be known and supplied with as much precision as possible.

The fertility status of most sugar beet soils requires the addition of only a fraction, but a highly important fraction, of the total nitrogen requirement of the sugar beet crop. A soil must be able to provide approximately 200 pounds of available nitrogen per acre in order to produce a 20-ton crop of

Figure 6.—**Furrow irrigation of sugar beets.**

sugar beets. An acre of typical soil in the sugar beet producing area releases 130 to 160 pounds of nitrogen annually. On such a soil a farmer must add 40 to 70 pounds of available nitrogen as manure or commercial fertilizer in order to produce a 20-ton crop of beets. Where 30 tons of beets are the goal, he must provide 140 to 170 pounds of available nitrogen per acre. The quantity of barnyard manure or commercial nitrogen-fertilizer you need to provide depends on the yield you expect and the nitrogen-supplying power of your soil.

Pending the perfection of soil tests for available nitrogen, growers must rely on their experience or on the limited help of "plant tissue tests" (petiole analysis). Twenty petioles are analyzed. They are selected from the recently matured leaves of beets from all parts of the field in such a manner as to represent the area to be tested. In order to avoid limitations on growth of beets, the nitrate-nitrogen concentra-

tion in these petioles should not be less than 1,000 p.p.m. on the oven-dry weight basis. The only exception to this is the period 2 weeks previous to harvest. A low nitrate-nitrogen content 2 weeks previous to harvest favors a high sugar content in the beet without reducing yield. While plant tissue tests have proved helpful in the longer seasons of California, they have not been a practical basis for current-season fertilization to growers in short-season areas. Specific information for your area can be obtained from your county agent, sugar beet company fieldman, or a soil-testing laboratory.

Experience of farmers indicates that 40 to 60 pounds of commercial nitrogen may be needed in the short-season areas (150 to 180 days from seeding to harvesttime), 60 to 120 pounds in the medium-season areas (180 to 240 days), and 120 to 180 pounds per acre in the long-season areas (240 to 300 days) for satisfactory yield and quality of beets. These are only approximations and will be modified by crop rotation, quantity of barnyard manure used, and other factors.

Phosphorus

Many soils are so low in available phosphorus that large quantities must be added for good sugar beet production.

Phosphorus is not leached from the soil. Soil tests can be used to determine available soil phosphorus levels. Researchers have found that when the first 6 inches of soil contains more than 50 pounds of sodium-bicarbonate-soluble phosphorus per acre, it will supply adequate phosphorus for sugar beets. Once sufficient phosphorus has been added to the soil to supply 50 pounds per acre of sodium-bicarbonate-soluble phosphorus, this level can thereafter be maintained by adding 500 to 600 pounds of treble superphosphate once every 5 years. This can be applied to the crop preceding sugar beets or in the spring before seeding the current sugar beet crop. Check the available phosphorus supply in your soil at least every 5 years.

Scientists have developed another method for testing the availability of phosphorus. With this method, the concentration of soluble phosphorus in the recently mature leaf petiole is used as an indication of phosphorus nutritional status. The soluble phosphorus concentration should not fall below the critical level of 750 p.p.m. in the dry petioles at any time. This method is being successfully used in California as a basis for current season fertilizer practices, as well as an indication of the ability of the soil to supply adequate quantities of phosphorus.

Either of the above methods (soil or petiole analysis) is satisfactory to guide sugar beet growers in phosphorus fertilization.

Fertilizer Materials

Phosphorus and nitrogen needs can be met by application of a number of fertilizers such as 16–20–0, 11–48–0, and 22–15–0. Liquid phosphoric acid, treble superphosphate, and single superphosphate are satisfactory forms of phosphorus. Anhydrous ammonia, liquid ammonia, ammonium nitrate, ammonium sulfate, and urea are readily available sources of nitrogen.

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